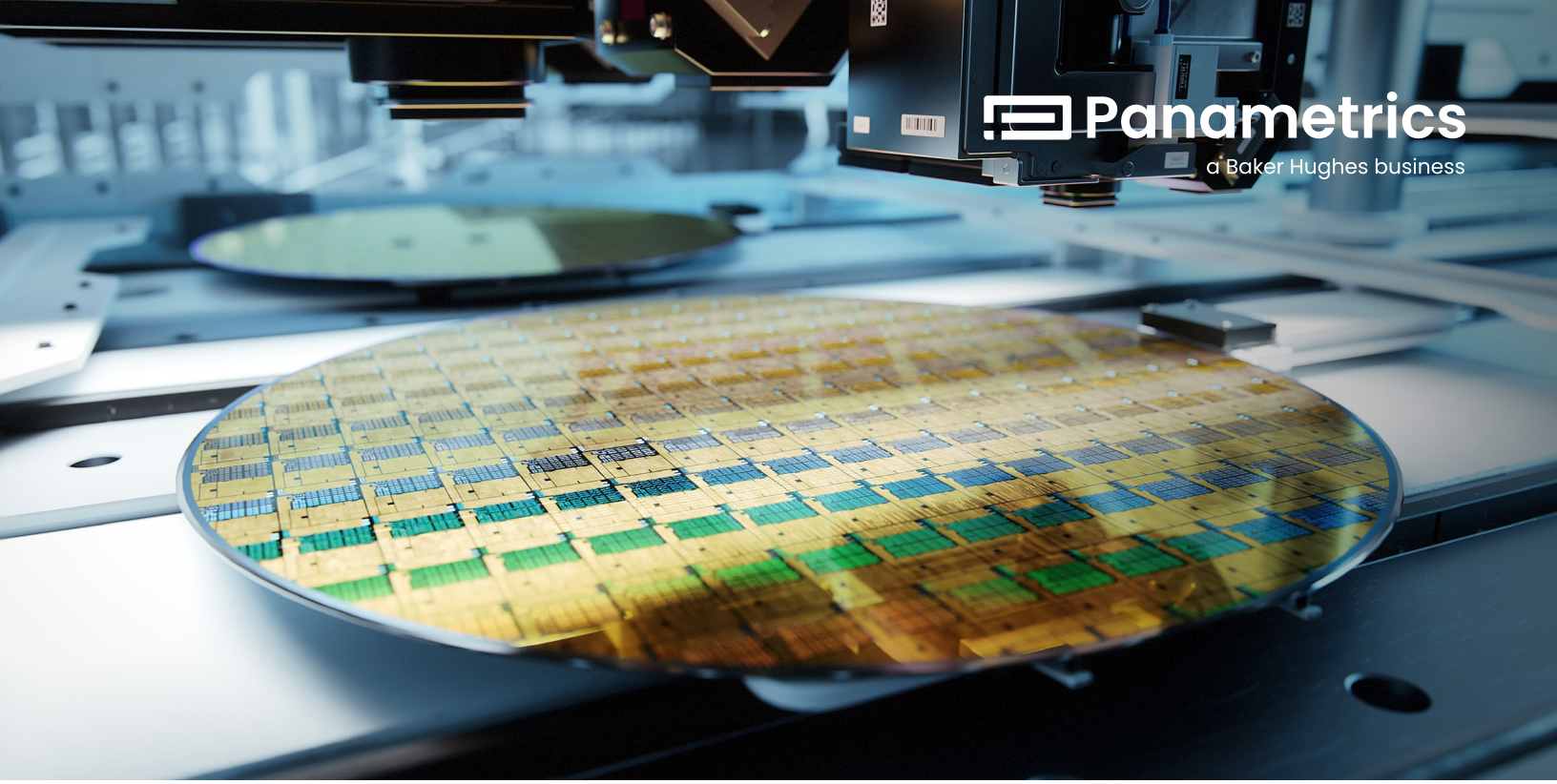

Application Note

Measuring impurities in semiconductor fabrication process gases

Summary

A challenge in semiconductor manufacturing is monitoring and controlling impurities in ultra-high purity gases and working environments. Measurement of contaminants needs to be accurate and, in some cases, to parts per billion. Poor or lack of measurement can mean the difference between success and failure. Panametrics' wide array of moisture and gas analyzer systems enables the semiconductor fabricator to monitor and measure purity confidently.

BENEFITS

- Fast, easy one-point calibration that is sufficient for entire range from ppm to percent oxygen
- Oxygen measurement from 0.1 ppm to 100%
- Capable of measuring oxygen in reducing gases
- Fast response (90% of step change in under two seconds)
- Low maintenance

Application

Cell phones, consumer electronics, and artificial intelligence-enhanced automobiles, appliances, and other technology are pushing the need for semiconductors to new heights. Advanced memory chips also contribute to this market. So great is this demand that most experts agree the compounded annual growth rate through 2029 will approach 10%.

Semiconductor fabrication is an intensive, time-consuming process that requires absolute precision. For instance, the nitrogen used for 3D NAND flash memory fab needs to be 99.999% pure. Other elemental gases like oxygen, argon, hydrogen, helium, and carbon dioxide also come into play in chip manufacturing, and all must be measured for purity with the same rigor.

Measuring trace gas impurities plays an essential role in the quality equation of semiconductor manufacturing.

Challenge

In the semiconductor manufacturing process, the challenge in monitoring invisible materials like moisture and oxygen is their insidious nature. These impurities are ever-present and can negatively impact chip production when amassed in the slightest concentrations. Moisture and oxygen can have deleterious effects even at parts per billion (ppb) levels. The percentage of usable chips (those that aren't discarded) is a criterion for successful fabrication. If more than one in 10 chips is discarded, it could mean the difference between the success and failure of a fab. Contaminants reduce yield, increase cost, and lead to overall poor product quality. Diligent monitoring of gas purity is the only way to avoid catastrophe.

Solution

When it comes to limiting the contaminants in semiconductor manufacturing processes, Panametrics understands that accuracy and reliability are two of the most significant factors in choosing a moisture or gas analyzer. To be effective, analyzers must continuously monitor contaminants in both electronic grade and bulk gases.

Deploying analyzers in a three-tiered approach is the best way to ensure early detection of leaks or identify a collection of contaminants. Analyzer placement begins at the perimeter or source of gas entry into the fabrication facility and then progresses more deeply into the plant. Analyzers should be placed throughout the gas distribution system and ultimately at the point of use. These successive layers of cordoning allow for quick rectification in the event of a problem and avoid prolonged process inefficiencies.

The Panametrics CGA 351 Zirconia Oxygen Analyzer is one example of a solution that may be deployed in a semiconductor fab. Research has shown that precise control of the oxide layer on the surface of a semiconductor is required to provide mechanical protection by isolating the transistor surface from electrical, mechanical, and chemical conditions in the environment. Panametrics demonstrated the fast response, low required sample volume, and precision of the CGA 351 Zirconia Oxygen Analyzer working with a university developing superconductors. The analyzer was installed, and the 4 – 20 mA output was used to maintain oxygen within a crystallization chamber at a consistent 2% by volume.

To ensure a solution for every application, Panametrics has developed a variety of moisture and gas analyzers to meet the need. For instance, applications related to the semiconductor manufacturing processes might include measuring trace elements in air separation units, moisture measurement in instrument air throughout fabrication facilities, or verifying measurements of inline analyzers. For each scenario, Panametrics, which has set the industry standard for process analyzers, offers the best combination of technologies to deliver the measurements required for the applications that are relevant to the industry.

About Panametrics

Panametrics, a Baker Hughes business, develops solutions for measuring and analyzing moisture, oxygen, liquid, steam, and gas flow with proven technologies that are well-known and widely deployed across many industries, including oil and gas.

For more than 60 years, we've been constantly evolving our product line to deliver the most effective moisture and gas measurement systems on the planet. Today, the culmination of decades of expertise, insight, and innovation is expressed in our Sentinel portfolio of high-accuracy liquid flow meters that cover a range of operating temperatures and applications.

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